Standard for Extended Detention Basins

Definition

A extended detention basin is an impoundment area made by constructing an embankment and/or excavating a pit. An extended detention basin is usually designed as a two stage detention structure (Figure 1).

Purpose

Extended detention basins provide for (1) normal flood routing and (2) moderate water quality improvement by use of a multi-stage design. Upper stages regulate peak rates of flow for flood and erosion control. The lower stage is designed for entrapment of pollutants via sedimentation (settlement) by capturing the high-frequency water quality storm and detaining it for a specified period of time. Extended detention basins are designed for complete evacuation of runoff and remain dry between storm events. However, to enhance soluble pollutant removal, the lower stage of the basin may be designed and maintained as a permanent pool or wetland (see Standard for Wet Pond or Standard for Stormwater Wetlands).

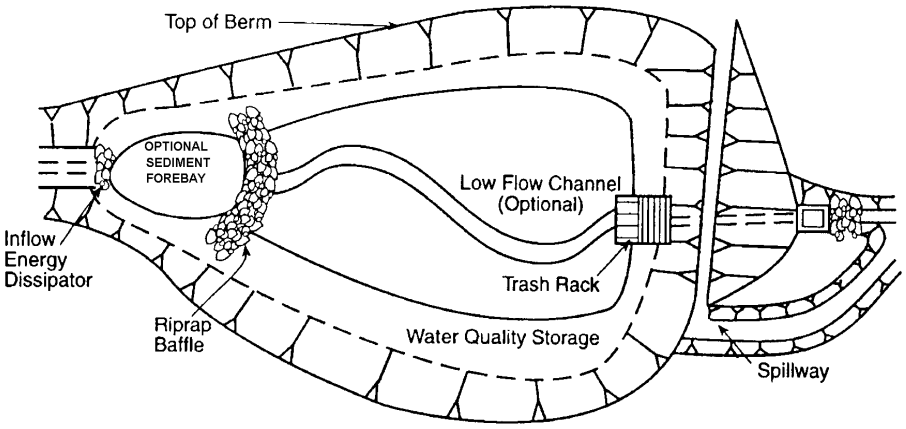
Conditions Where Practice Applies

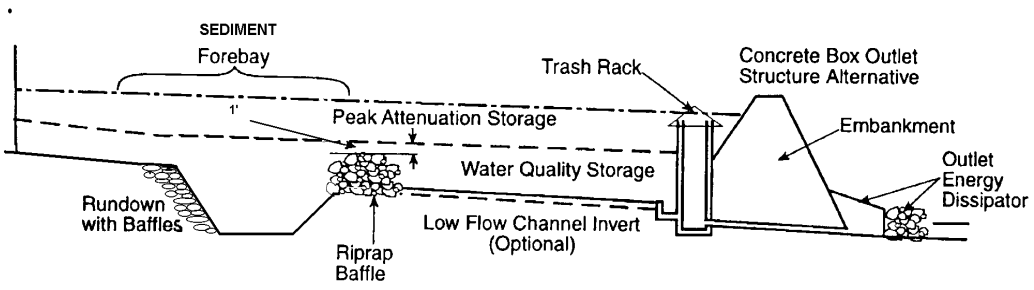
Extended detention basins may be used in new construction where a significant increase of runoff is produced by post-development conditions. Existing basins may be *retrofitted* for extended detention and improved outflow water quality by modifying the structure, provided that flood control remains unchanged, and additional maintenance duties are understood.

Extended detention basins are used for drainage areas ranging in size from one to several hundred acres.

Although extended detention basins can be used at residential, commercial and industrial sites, limited effectiveness in removing soluble pollutants should be a prime factor when being considered for water quality treatment. These basins are applicable in commercial areas where the percentage of impervious surface is relatively high and sediment, heavy metals and hydrocarbons are the target pollutants. Low density residential areas where soluble materials from fertilizers and pesticides may be present should consider alternate or additional water quality measures found in this manual.

The most critical parameter in the design of an extended detention basin is the detention time which in turn determines the basin volume for a given design storm and the extent of pollutant removal. Although the bulk of the settling has been shown to occur in the first 12 hours in the laboratory experiments, additional detention time is needed to allow for settling conditions to develop in the detention basin. **A minimum 24 hour detention time is used in this manual to achieve estimated pollutant concentration reductions.**





(Adapted from *Dam Design and Construction Standards*, Fairfax County, Virginia, 1991)

Figure 1. Typical Extended Detention Basin

Design Criteria

The sizing of the detention basin is dictated by the runoff volume to be detained over a specified period of time to enhance water quality. As a minimum, the detention basin should be sized to accommodate the runoff generated by the stormwater quality design storm. Not more than 10% of the total runoff volume from this design storm may remain after a minimum of 24 hours for both

residential and commercial developments. Detention time is measured from the time of runoff reaching the peak water quality storm elevation within the basin.

Basin Volume and Features:

A. The initial volume of the *water quality* storage portion of the basin shall be based on the following method:

- Apply the water-quality design storm (1.25 inches of rainfall over two hours).

The final volume shall be determined by flood routing using USDA NRCS TR-20, US Army Corps of Engineers HEC-1 or other methods which produce similar results.

B. Estimating Storage Volume

Similar to the techniques used to estimate the required flood storage volume, the stormwater quality estimating technique uses inflow to conservatively estimate the maximum depth that will occur in the basin during the stormwater quality design storm. This depth can then be used to estimate both the outlet orifice necessary to achieve the required detention time and the elevation of the next higher stage outlet to be used for flood control purposed. Refinements of the estimated outlet size and higher stage elevation shall be done through conventional routing analysis. The process is as follows:

1. Using the NJDEP stormwater quality design storm rainfall, estimate the total runoff volume that is expected to flow into the basin from the development site. The volume of runoff shall be determined from impervious surfaces only.

2. Using the total runoff volume estimate determined in (a), and neglecting any outflow, determine the peak depth of the runoff volume in the detention basin.

3. Flood route the basin using a three inch orifice (minimum) at the basin outlet invert. Ten percent of the stormwater volume should remain after a minimum of 24 hours for residential and commercial sites. Detention time is measured from the time of reaching the peak water quality storm elevation. Repeat the process (if necessary), adjusting the

basin configuration and/or orifice size to achieve the required detention goals. If the required detention time cannot be met, additional stormwater quality standards must be utilized in conjunction with the water quality basin design.

4. Provide design for other required design storms pursuant to local or state requirements.

C. Wetland Creation

A wetland area can be established in the bottom stage of an extended detention facility. Wetland vegetation aids in stabilizing bottom sediments and soluble pollutants, especially the nutrients which will otherwise pass through untreated. In addition, the emergent marsh plants provide an attractive habitat for both wildlife and waterfowl, enhance sediment trapping and prevent sediment re-suspension. Refer to Standard for Stormwater Wetlands.

D. Sediment Accumulation

A properly designed detention basin will accumulate considerable amounts of sediment over time, leading to the loss of the detention volume and thus pollutant removal efficiency. Therefore, depending upon the clean-out intervals, an accommodation must be made in the original design to compensate for the loss of this detention volume.

E. Basin Configuration

An extended or a extended detention basin relies on the process of sedimentation for removal of runoff pollutants. In order to maximize the degree of sedimentation, the basin shall be designed:

- To lengthen flow paths and increase detention time using long, narrow basin configurations with length to width ratios of 2:1 to 3:1 or,

- The use of basin designs that are shallow and have large bottom surface areas will also provide better removal efficiencies than small deep basin designs.

- The forebay, for enhanced sediment accumulation, should be a minimum of 10 feet long along the flow path, located and sized as shown in Figures 1 and 2. Sufficient sediment storage should be provided to hold sediment between clean out intervals (3-5 years). Access for maintenance must be included.

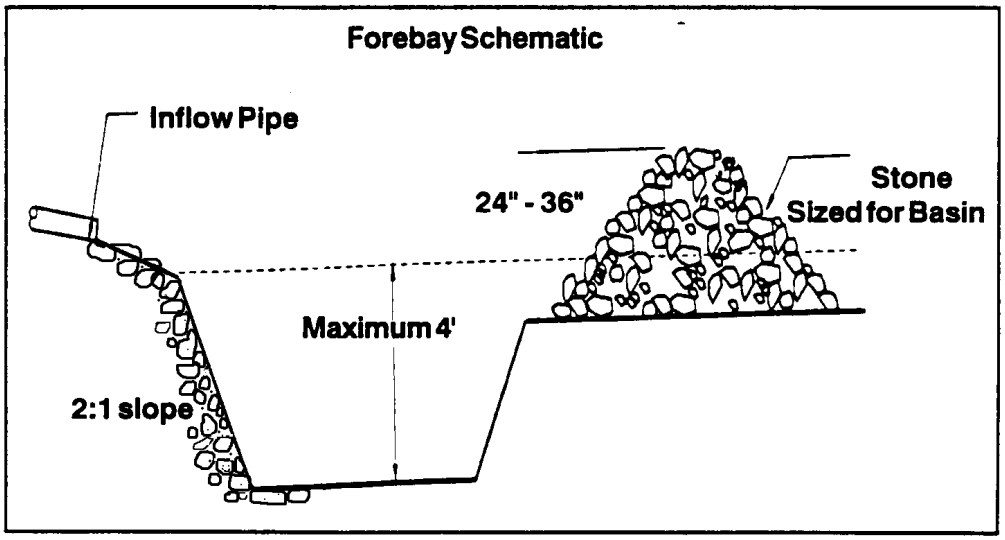


Figure 2. Typical forebay

Note: Refer to New Jersey Standards for Soil Erosion and Sediment Control, Appendix: Structural Guidelines for basin slopes and outlet structures.

F. Outlet Protection

Refer to the NJ Standards for Soil Erosion and Sediment Control for New Jersey, Standard for Conduit Outlet Protection for design criteria, pg. 12-1. Conduit outlet protection must be used at all inflow and outflow points.

G. Vegetative Cover

Refer to the Standards for Soil Erosion and Sediment Control in New Jersey, Standard for Permanent Vegetative Cover for Soil Stabilization, or the USDA-NRCS Field Office Technical Guide, Standard 342.

Considerations

For effective water quality control, the basin must collect all runoff from the site, especially the impervious areas such as roadways and parking lots. The majority of the key pollutants that are removed by extended detention basins originate on these surfaces.

A typical extended detention basin will range from three to twelve feet in depth. Depth is often limited by ground water conditions or by the need for positive drainage from excavated basins. At the location of the proposed extended detention basin, the depth to seasonal high water table (SHWT) should be identified. If the basin is to intercept the ground water table, the effects of seepage on the basin slopes should be investigated. Basins that do intercept the SHWT may have unstable side slopes and may create maintenance problems due to seepage, especially where mowing is required.

When designing a extended detention basin, bottom soils should be examined. If soils are relatively impermeable (USDA Hydrologic Soil Group "D"), a dry extended detention basin may exhibit problems with standing water. Conversely, if soils are very permeable (Group "A") the effects on ground water should be considered. If bedrock lies close to the surface of the soil, excavation for necessary storage volume may be too costly and difficult. In Karst topography other alternatives to detention basins should be examined.

Operations and Maintenance

Proper maintenance of extended detention basins is crucial for these facilities to continue functioning as designed. Often, perceived disadvantages of extended detention, such as mosquito problems, can be attributed to neglected maintenance. Wherever possible, basins should be designed which require minimal maintenance. The following lists preventative, corrective and aesthetic maintenance requirements inherent to extended detention basins. Details on maintenance are discussed comprehensively in the Stormwater Management Facilities Maintenance Manual, NJDEP, 1989; and Chapter 6 of this manual.

To control weeds, disease and pests, a regularly scheduled program of mowing and trimming of bottoms, side-slopes and embankments should be tailored to each extended detention basin based on site conditions, grass type and seasonal variations. Grassed areas also require periodic prudent fertilizing, dethatching and soil conditioning to maintain healthy growth. Trees, shrubs and other vegetative cover also require periodic maintenance such as fertilizing, pruning and pest control to maintain healthy growth.

A regularly scheduled program of debris and trash removal will reduce the chance of outlet structures, trash racks and other components becoming clogged and inoperable during storm events. In addition, removal of these items eliminates potential mosquito breeding habitats and damage to the vegetated areas of the basin. Disposal of debris and trash must comply with local, state and federal waste regulations. Only suitable disposal/recycling sites should be used.

Inspections by qualified personnel should be conducted at least once a year. Inspections should occur during wet weather to verify that the basin is meeting targeted detention times. Evidence of clogging or rapid release should be investigated. In addition, subsidence, erosion, cracking, unwanted tree growth, condition of the emergency spillway, accumulation of sediment around outlets etc. shall be cause for corrective maintenance measures to be undertaken . These inspections should be used to determine the effectiveness of the regular maintenance schedule as well as determine the timing of corrective maintenance procedures.